International
IOR Rectifier

June 1, 2011
IRS2609DSPbF

HALF-BRIDGE DRIVER

Features

- Floating channel designed for bootstrap operation
  Fully operational to +600 V
  Tolerant to negative transient voltage – dV/dt immune
- Gate drive supply range from 10 V to 20 V
- Undervoltage lockout for both channels
- 3.3 V, 5 V and 15 V input logic compatible
- Cross-conduction prevention logic
- Matched propagation delay for both channels
- High side output in phase with IN input
- Internal 530 ns dead-time
- Lower di/dt gate driver for better noise immunity
- Shut down input turns off both channels
- Integrated bootstrap diode
- RoHS compliant

Packages



8-Lead SOIC

Product Summary

V_{OFFSET}	600 V max.
$I_{O+/-}$	120 mA / 250 mA
V_{OUT}	10 V – 20 V
$t_{on/off}$ (typ.)	750 ns & 200 ns
Dead Time	530 ns

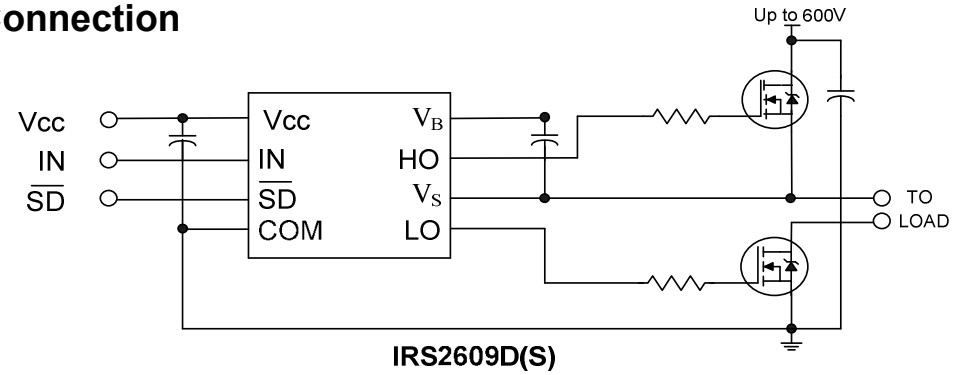
Description

The IRS2609D is a high voltage, high speed power MOSFET and IGBT drivers with dependent high and low side referenced output channels. Proprietary HVIC and latch immune CMOS technologies enable ruggedized monolithic construction. The logic input is compatible with Standard CMOS or LSTTL output, down to 3.3 V logic. The output drivers feature a high pulse current buffer stage designed for minimum driver cross-conduction. The floating channel can be used to drive an N-channel power MOSFET or IGBT in the high side configuration which operates up to 600 V.

Applications:

*Air Conditioner
*Micro/Mini Inverter Drives
*General Purpose Inverters
*Motor Control

Typical Connection



IRS2609D(S)

(Refer to Lead Assignments for correct pin configuration). This/These diagram(s) show electrical connections only. Please refer to our Application Notes and Design Tips for proper circuit board layout.

Qualification Information†

Qualification Level		Industrial††
		Comments: This IC has passed JEDEC's Industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level.
Moisture Sensitivity Level		MSL2, 260°C (per IPC/JEDEC J-STD-020)
ESD	Human Body Model	Class 2 (per JEDEC standard JESD22-A114)
	Machine Model	Class B (per EIA/JEDEC standard EIA/JESD22-A115)
IC Latch-Up Test		Class I, Level A (per JESD78)
RoHS Compliant		Yes

† Qualification standards can be found at International Rectifier's web site http://www.irf.com/

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information.

Absolute Maximum Ratings

Absolute Maximum Ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

Symbol	Definition	Min.	Max.	Units
V_B	High side floating absolute voltage	-0.3	620	V
V_S	High side floating supply offset voltage	V_B - 20	V_B + 0.3	
V_{HO}	High side floating output voltage	V_S - 0.3	V_B + 0.3	
V_{CC}	Low side and logic fixed supply voltage	-0.3	20	
V_{LO}	Low side output voltage	-0.3	V_{CC} + 0.3	
V_{IN}	Logic input voltage (IN & SD)	COM -0.3	V_{CC} + 0.3	
COM	Logic ground	V_{CC} - 20	V_{CC} + 0.3	
dV_S/dt	Allowable offset supply voltage transient	—	50	V/ns
P_D	Package power dissipation @ TA ≤ +25 °C	—	0.625	W
Rth_{JA}	Thermal resistance, junction to ambient	—	200	°C/W
T_J	Junction temperature	—	150	°C
T_S	Storage temperature	-50	150	
T_L	Lead temperature (soldering, 10 seconds)	—	300	

Recommended Operating Conditions

For proper operation the device should be used within the recommended conditions. The V_S and COM offset rating are tested with all supplies biased at 15 V differential.

Symbol	Definition	Min.	Max.	Units
V_B	High side floating supply absolute voltage	V_S +10	V_S +20	V
V_S	Static High side floating supply offset voltage	COM- 8(Note 1)	600	
V_{St}	Transient High side floating supply offset voltage	-50 (Note2)	600	
V_{HO}	High side floating output voltage	V_S	V_B	
V_{CC}	Low side and logic fixed supply voltage	10	20	
V_{LO}	Low side output voltage	0	V_{CC}	
V_{IN}	Logic input voltage (IN & SD)	V_{SS}	V_{CC}	
T_A	Ambient temperature	-40	125	°C

Note 1: Logic operational for V_S of -8 V to +600 V. Logic state held for V_S of -8 V to – V_{BS}.
Note 2: Operational for transient negative VS of COM - 50 V with a 50 ns pulse width. Guaranteed by design. Refer to the Application Information section of this datasheet for more details.

Dynamic Electrical Characteristics

V_{BIAS} (V_{CC}, V_{BS}) = 15 V, COM = V_{CC}, C_L = 1000 pF, T_A = 25 °C, DT = V_{SS} unless otherwise specified.

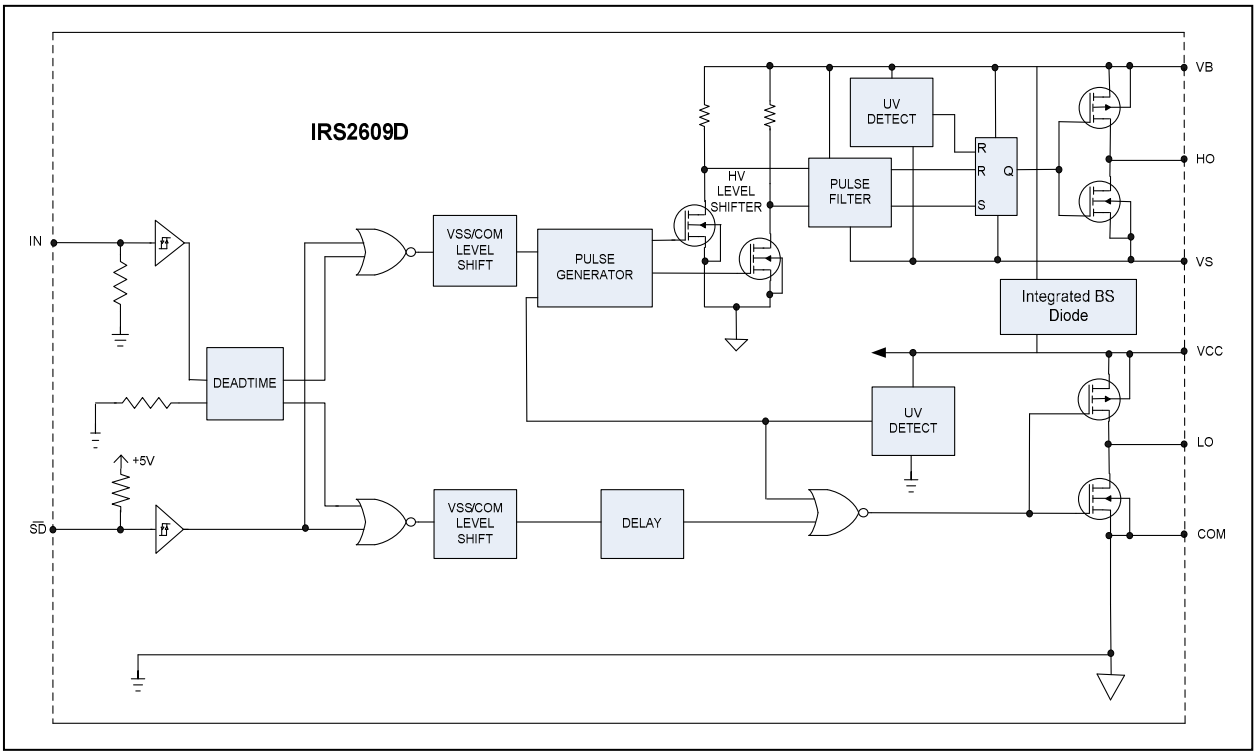
Symbol	Definition	Min	Typ	Max	Units	Test Conditions
t_{on}	Turn-on propagation delay	—	750	1100	ns	V_S = 0 V or 600 V
t_{off}	Turn-off propagation delay	—	250	400		V_S = 0 V or 600 V
t_{sd}	Shut-down propagation delay	—	250	400		
MT	Delay matching, HS & LS turn-on/off	—	—	60		
t_r	Turn-on rise time	—	150	220		V_S = 0 V
t_f	Turn-off fall time	—	50	80		V_S = 0 V
DT	Deadtime: LO turn-off to HO turn-on(DT_{LO-HO}) & HO turn-off to LO turn-on (DT_{HO-LO})	350	530	800		V_{IN} = 0 V & 5 V Without external deadtime
MT	Delay matching time (t_{ON} , t_{OFF})	—	—	60		
MDT	Deadtime matching = DT_{LO-HO} - DT_{HO-LO}	—	—	60		

Static Electrical Characteristics

V_{BIAS} (V_{CC}, V_{BS}) = 15 V, V_{CC} = COM, DT = V_{CC} and T_A = 25 °C unless otherwise specified. The V_{IL}, V_{IH} and I_{IN} parameters are referenced to V_{CC}/COM and are applicable to the respective input leads: IN and $\overline{SD}$. The V_O, I_O and Ron parameters are referenced to COM and are applicable to the respective output leads: HO and LO.

Symbol	Definition	Min	Typ	Max	Units	Test Conditions
V_{IH}	logic “1” input voltage for HO & logic “0” for LO	2.2	—	—	V	
V_{IL}	logic “0” input voltage for HO & logic “1” for LO	—	—	0.8		
V_{OH}	High level output voltage, V_{BIAS} - V_O	—	0.8	1.4		I_O = 20 mA
V_{OL}	Low level output voltage, V_O	—	0.3	0.6		I_O = 20 mA
I_{LK}	Offset supply leakage current	—	—	50	μA	V_B = V_S = 600 V
I_{QBS}	Quiescent V_{BS} supply current	—	45	70		V_{IN} = 0 V or 4 V
I_{QCC}	Quiescent V_{CC} supply current	1000	2000	3000		V_{IN} = 0 V or 4 V
I_{IN+}	Logic “1” input bias current	—	5	20		V_{IN} = 4 V
I_{IN-}	Logic “0” input bias current	—	—	2		V_{IN} = 0 V
$I_{SD, TH+}$	$\overline{SD}$ input positive going threshold	—	15	30		
$I_{SD, TH-}$	$\overline{SD}$ input negative going threshold	—	10	20		
V_{CCUV+} V_{BSUV+}	V_{CC} and V_{BS} supply undervoltage positive going Threshold	8.0	8.9	9.8	V	
V_{CCUV-} V_{BSUV-}	V_{CC} and V_{BS} supply undervoltage negative going Threshold	7.4	8.2	9.0		
V_{CCUVH} V_{BSUVH}	Hysteresis	—	0.7	—		
I_{O+}	Output high short circuit pulsed current	120	200	—	mA	V_O = 0 V, PW ≤ 10 us
I_{O-}	Output low short circuit pulsed current	250	350	—		V_O = 15 V, PW ≤ 10 us
Rbs	Bootstrap resistance	—	200	—	Ohm	

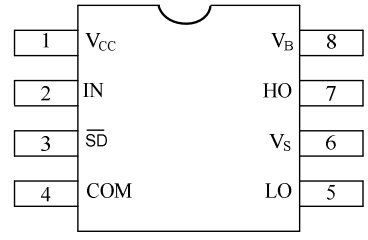
Functional Block Diagrams



Lead Definitions

Symbol	Description
IN	Logic input for high and low side gate driver outputs (HO and LO), in phase
$\overline{SD}$	Logic input for shutdown
V_B	High side floating supply
HO	High side gate drive output
V_S	High side floating supply return
V_{CC}	Low side and logic fixed supply
LO	Low side gate drive output
COM	Low side return

Lead Assignments



8 Lead SOIC

IRS2609DS

Application Information and Additional Details

Informations regarding the following topics are included as subsections within this section of the datasheet.

- IGBT/MOSFET Gate Drive
- Switching and Timing Relationships
- Deadtime
- Matched Propagation Delays
- Shut down Input
- Input Logic Compatibility
- Undervoltage Lockout Protection
- Shoot-Through Protection
- Integrated Bootstrap Functionality
- Negative V_S Transient SOA
- PCB Layout Tips
- Integrated Bootstrap FET limitation
- Additional Documentation

IGBT/MOSFET Gate Drive

The IRS2609D HVICs are designed to drive MOSFET or IGBT power devices. Figures 1 and 2 illustrate several parameters associated with the gate drive functionality of the HVIC. The output current of the HVIC, used to drive the gate of the power switch, is defined as I_O. The voltage that drives the gate of the external power switch is defined as V_{HO} for the high-side power switch and V_{LO} for the low-side power switch; this parameter is sometimes generically called V_{OUT} and in this case does not differentiate between the high-side or low-side output voltage.

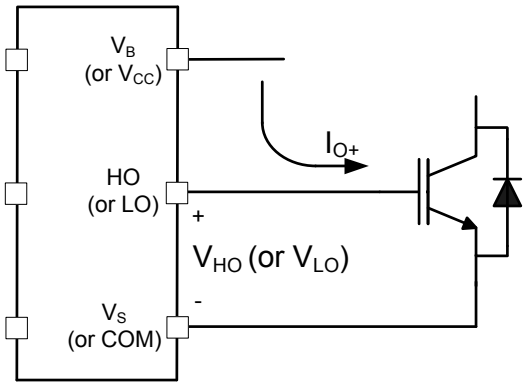


Figure 1: HVIC sourcing current

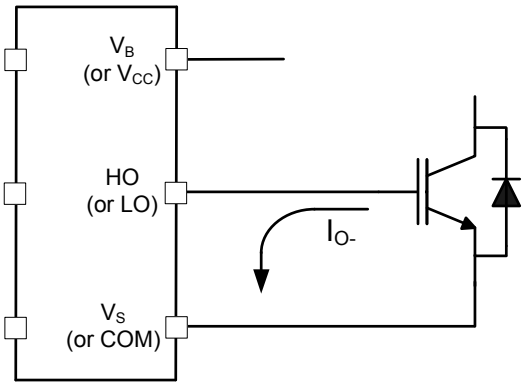


Figure 2: HVIC sinking current

Switching and Timing Relationships

The relationships between the input and output signals of the IRS2609D are illustrated below in Figures 3, 4. From these figures, we can see the definitions of several timing parameters (i.e. t_{ON}, t_{OFF}, t_R, and t_F) associated with this device.

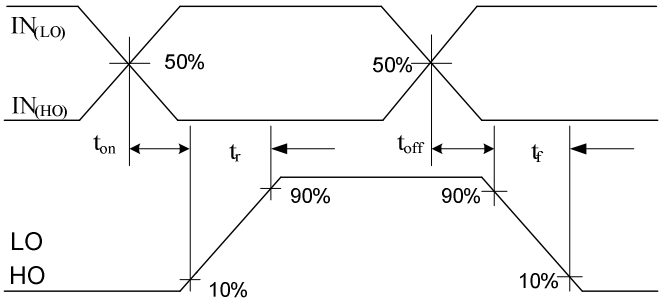


Figure 3: Switching time waveforms

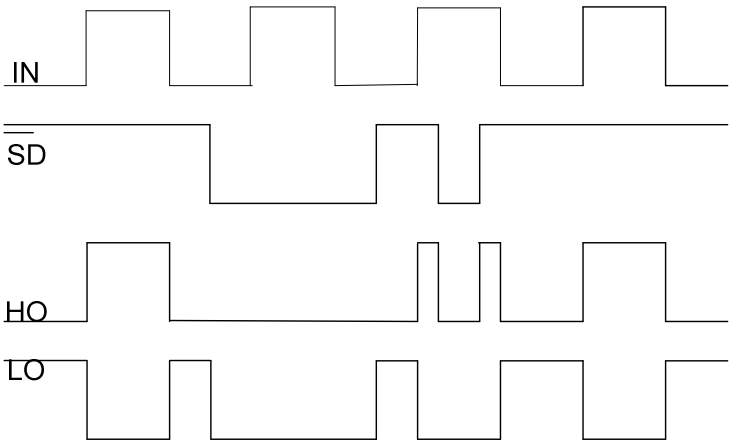


Figure 4: Input/output timing diagram

Deadtime

This family of HVICs features integrated deadtime protection circuitry. The deadtime for these ICs is fixed; other ICs within IR's HVIC portfolio feature programmable deadtime for greater design flexibility. The deadtime feature inserts a time period (a minimum deadtime) in which both the high- and low-side power switches are held off; this is done to ensure that the power switch being turned off has fully turned off before the second power switch is turned on. This minimum deadtime is automatically inserter whenever the external deadtime is shorter than DT; external deadtimes larger than DT are not modified by the gate driver. Figure 5 illustrates the deadtime period and the relationship between the output gate signals.

The deadtime circuitry of the IRS2609D is matched with respect to the high- and low-side outputs. Figure 6 defines the two deadtime parameters (i.e., DT_{LO-HO} and DT_{HO-LO}); the deadtime matching parameter (MDT) associated with the IRS2609D specifies the maximum difference between DT_{LO-HO} and DT_{HO-LO}.

Matched Propagation Delays

The IRS2609D family of HVICs is designed with propagation delay matching circuitry. With this feature, the IC's response at the output to a signal at the input requires approximately the same time duration (i.e., t_{ON}, t_{OFF}) for both the low-side channels and the high-side channels; the maximum difference is specified by the delay matching parameter (MT). The propagation turn-on delay (t_{ON}) of the IRS2609D is matched to the propagation turn-on delay (t_{OFF}).

Shut down Input

The IRS2609D family of HVICs is equipped with a shut down (/SD) input pin that is used to shutdown or enable the HVIC. When the /SD pin is in the high state the HVIC is able to operate normally. When the /SD pin is in low state the HVIC is tristated.

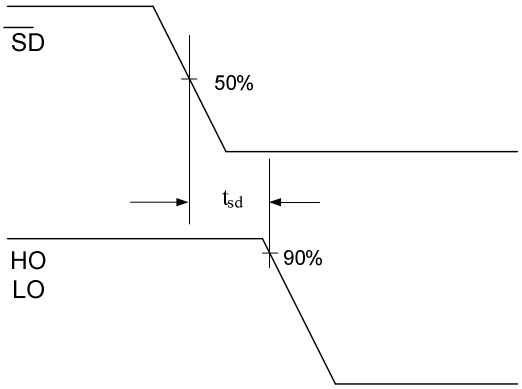


Figure 5: Shut down

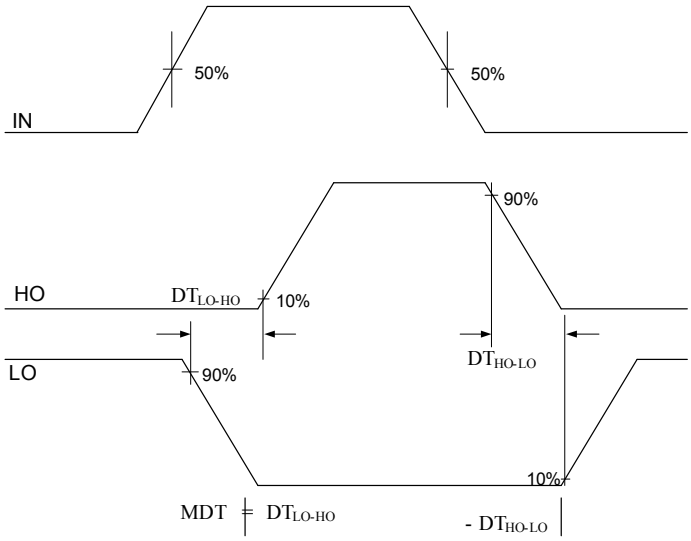


Figure 6: Dead time Definition

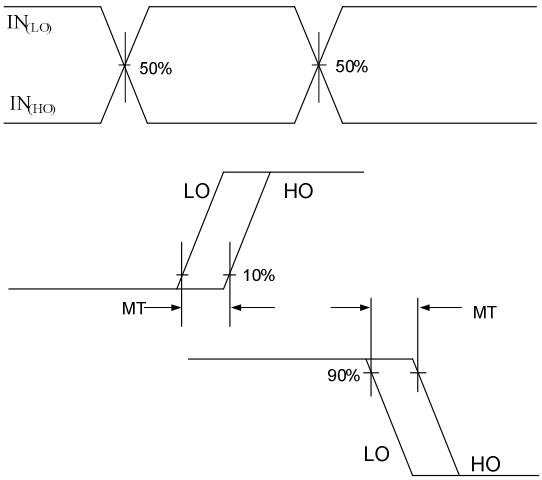


Figure 7: Delay Matching waveform Definition

Input Logic Compatibility

The inputs of this IC are compatible with standard CMOS and TTL outputs. The IRS2609D has been designed to be compatible with 3.3 V and 5 V logic-level signals. The IRS2609D features an integrated 5.2 V Zener clamp on the /SD. Figure 8 illustrates an input signal to the IRS2609D, its input threshold values, and the logic state of the IC as a result of the input signal.

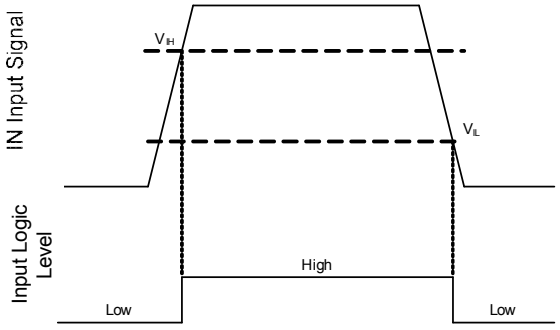


Figure 8: HIN & LIN input thresholds

Undervoltage Lockout Protection

This family of ICs provides undervoltage lockout protection on both the V_{CC} (logic and low-side circuitry) power supply and the V_{BS} (high-side circuitry) power supply. Figure 9 is used to illustrate this concept; V_{CC} (or V_{BS}) is plotted over time and as the waveform crosses the UVLO threshold ($V_{CCUV+/-}$ or $V_{BSUV+/-}$) the undervoltage protection is enabled or disabled.

Upon power-up, should the V_{CC} voltage fail to reach the V_{CCUV+} threshold, the IC will not turn-on. Additionally, if the V_{CC} voltage decreases below the V_{CCUV-} threshold during operation, the undervoltage lockout circuitry will recognize a fault condition and shutdown the high- and low-side gate drive outputs, and the FAULT pin will transition to the low state to inform the controller of the fault condition.

Upon power-up, should the V_{BS} voltage fail to reach the V_{BSUV} threshold, the IC will not turn-on. Additionally, if the V_{BS} voltage decreases below the V_{BSUV} threshold during operation, the undervoltage lockout circuitry will recognize a fault condition, and shutdown the high-side gate drive outputs of the IC.

The UVLO protection ensures that the IC drives the external power devices only when the gate supply voltage is sufficient to fully enhance the power devices. Without this feature, the gates of the external power switch could be driven with a low voltage, resulting in the power switch conducting current while the channel impedance is high; this could result in very high conduction losses within the power device and could lead to power device failure.

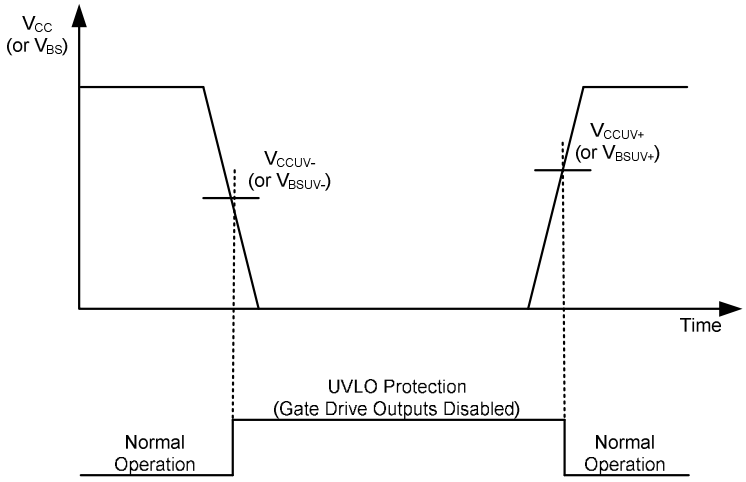


Figure 9: UVLO protection

Shoot-Through Protection

The IRS2609D high-voltage ICs is equipped with shoot-through protection circuitry (also known as cross-conduction prevention circuitry).

Integrated Bootstrap Functionality

The IRS2609D embeds an integrated bootstrap FET that allows an alternative drive of the bootstrap supply for a wide range of applications. A bootstrap FET is connected between the floating supply V_B and V_{CC} (see Fig. 10).

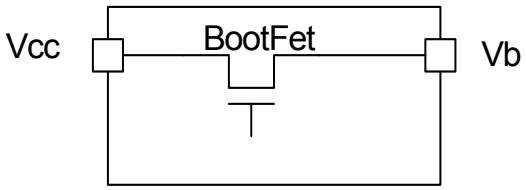


Figure 10: Semplified BootFET connection

The integrated bootstrap feature can be used either in parallel with the external bootstrap network (diode and resistor) or as a replacement of it. The use of the integrated bootstrap as a replacement of the external bootstrap network may have some limitations at very high PWM duty cycle, corresponding to very short LIN pulses, due to the bootstrap FET equivalent resistance RBS.

The summary for the bootstrap state follows:

- **Bootstrap turns-off (immediately) or stays off when at least one of the following conditions are met***:*
  1- /SD is low
  2- /SD is high, IN is low and V_B is high (> 1.1*V_{CC})
  3- /SD is high, IN is high (DT period excluded)
  4- /SD is high, IN is high and V_B is high (> 1.1*V_{CC}) (during DT period)
- ***Bootstrap turns-on when***:
  1- /SD in high, IN is low and V_B is low (< 1.1(V_{CC}))
  2- /SD in high, IN is high and V_B is low (< 1.1(V_{CC})) (during the DT period). Please refer to the BootFET timing diagram for more details.

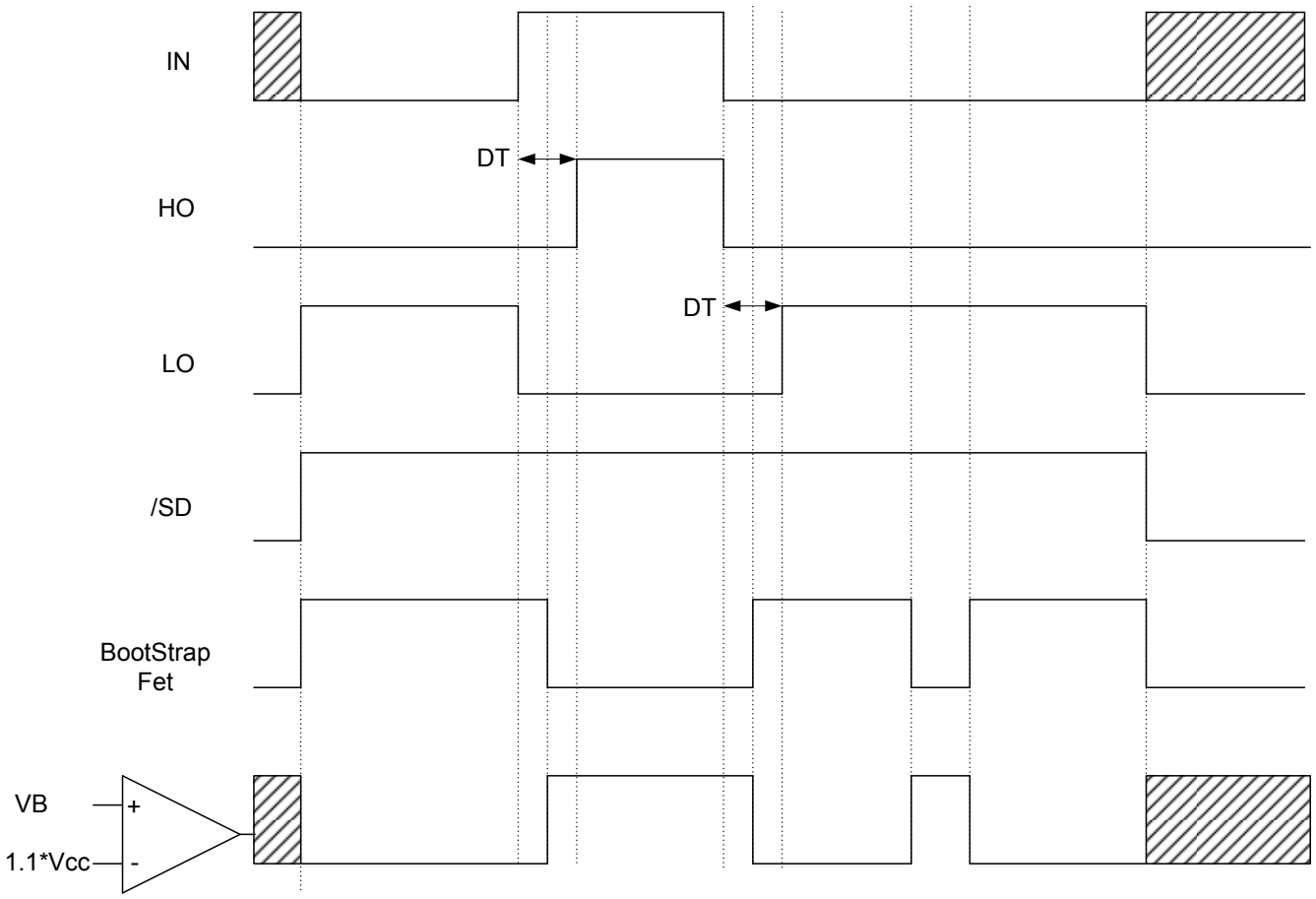


Figure 11: BootFET timing diagram

Negative V_S Transient SOA

A common problem in today's high-power switching converters is the transient response of the switch node's voltage as the power switches transition on and off quickly while carrying a large current. A typical 3-phase inverter circuit is shown in Figure 12; here we define the power switches and diodes of the inverter.

If the high-side switch (e.g., the IGBT Q1 in Figures 13 and 14) switches off, while the U phase current is flowing to an inductive load, a current commutation occurs from high-side switch (Q1) to the diode (D2) in parallel with the low-side switch of the same inverter leg. At the same instance, the voltage node V_{S1}, swings from the positive DC bus voltage to the negative DC bus voltage.

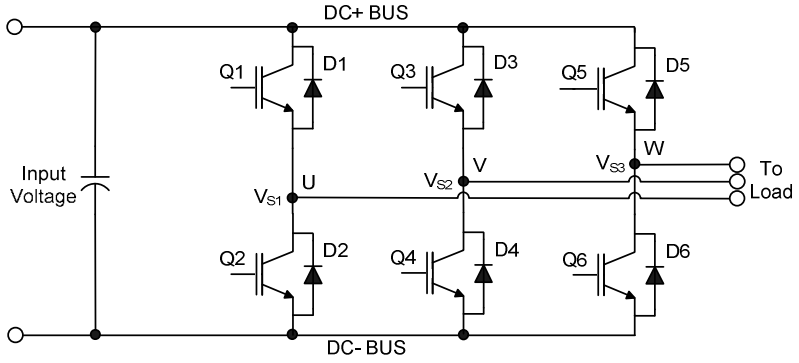


Figure 12: Three phase inverter

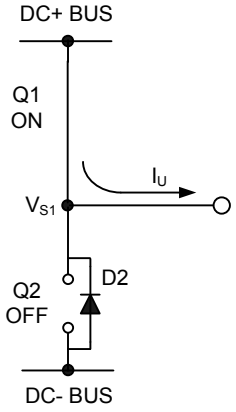


Figure 13: Q1 conducting

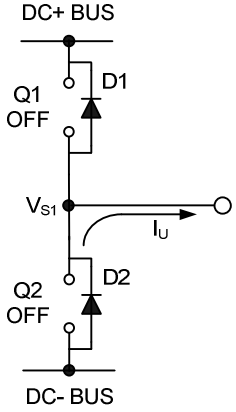


Figure 14: D2 conducting

Also when the V phase current flows from the inductive load back to the inverter (see Figures 15 and 16), and Q4 IGBT switches on, the current commutation occurs from D3 to Q4. At the same instance, the voltage node, V_{S2}, swings from the positive DC bus voltage to the negative DC bus voltage.

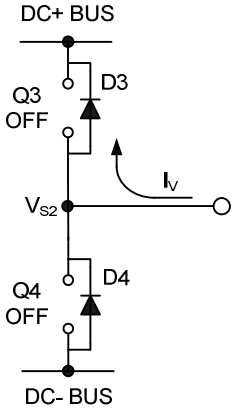


Figure 15: D3 conducting

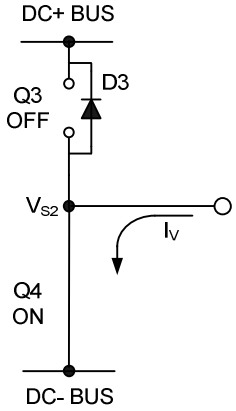


Figure 16: Q4 conducting

However, in a real inverter circuit, the V_S voltage swing does not stop at the level of the negative DC bus, rather it swings below the level of the negative DC bus. This undershoot voltage is called "negative V_S transient".

The circuit shown in Figure 17 depicts one leg of the three phase inverter; Figures 18 and 19 show a simplified illustration of the commutation of the current between Q1 and D2. The parasitic inductances in the power circuit from the die bonding to the PCB tracks are lumped together in L_C and L_E for each IGBT. When the high-side switch is on, V_{S1} is below the DC+ voltage by the voltage drops associated with the power switch and the parasitic elements of the circuit. When the high-side power switch turns off, the load current momentarily flows in the low-side freewheeling diode due to the inductive load connected to V_{S1} (the load is not shown in these figures). This current flows from the DC- bus (which is connected to the COM pin of the HVIC) to the load and a negative voltage between V_{S1} and the DC- Bus is induced (i.e., the COM pin of the HVIC is at a higher potential than the V_S pin).

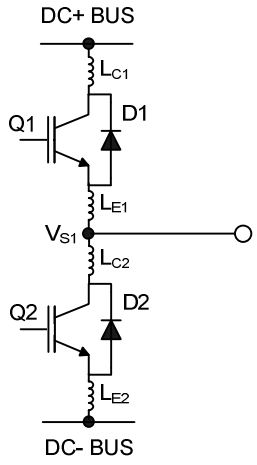


Figure 17: Parasitic Elements

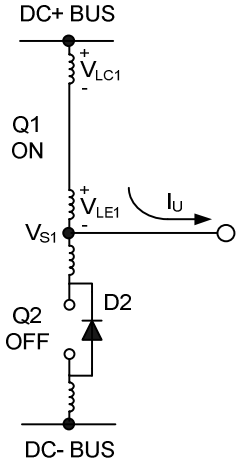


Figure 18: V_S positive

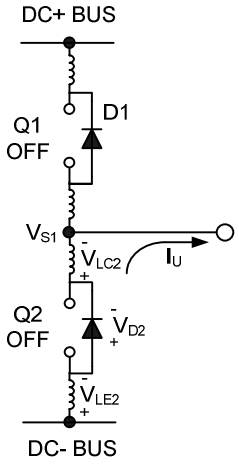


Figure 19: V_S negative

In a typical motor drive system, dV/dt is typically designed to be in the range of 3-5 V/ns. The negative V_S transient voltage can exceed this range during some events such as short circuit and over-current shutdown, when di/dt is greater than in normal operation.

International Rectifier's HVICs have been designed for the robustness required in many of today's demanding applications. An indication of the IRS2609D's robustness can be seen in Figure 20, where there is represented the IRS2609D Safe Operating Area at V_{BS}=15V based on repetitive negative V_S spikes. A negative V_S transient voltage falling in the grey area (outside SOA) may lead to IC permanent damage; viceversa unwanted functional anomalies or permanent damage to the IC do not appear if negative Vs transients fall inside SOA.
At V_{BS}=15V in case of -V_S transients greater than -16.5 V for a period of time greater than 50 ns; the HVIC will hold by design the high-side outputs in the off state for 4.5 µs.

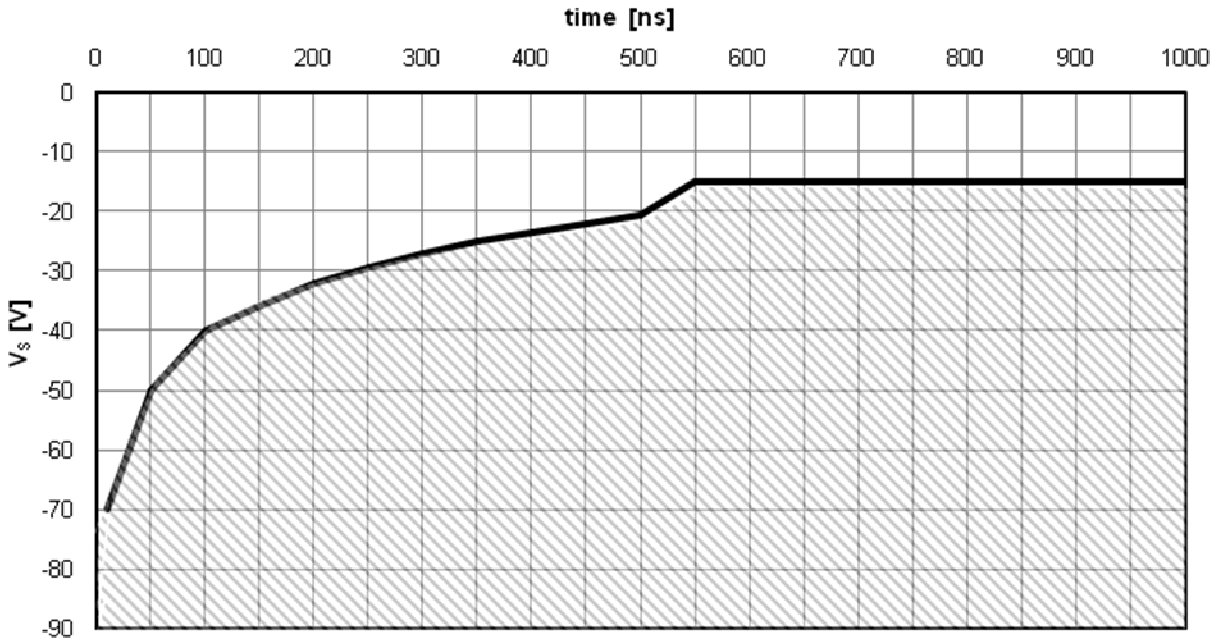


Figure 20: Negative V_S transient SOA for IRS2608D @ VBS=15V

Even though the IRS2609D has been shown able to handle these large negative V_S transient conditions, it is highly recommended that the circuit designer always limit the negative V_S transients as much as possible by careful PCB layout and component use.

PCB Layout Tips

Distance between high and low voltage components: It's strongly recommended to place the components tied to the floating voltage pins (V_B and V_S) near the respective high voltage portions of the device. Please see the Case Outline information in this datasheet for the details.

Ground Plane: In order to minimize noise coupling, the ground plane should not be placed under or near the high voltage floating side.

Gate Drive Loops: Current loops behave like antennas and are able to receive and transmit EM noise (see Figure 21). In order to reduce the EM coupling and improve the power switch turn on/off performance, the gate drive loops must be reduced as much as possible. Moreover, current can be injected inside the gate drive loop via the IGBT collector-to-gate parasitic capacitance. The parasitic auto-inductance of the gate loop contributes to developing a voltage across the gate-emitter, thus increasing the possibility of a self turn-on effect.

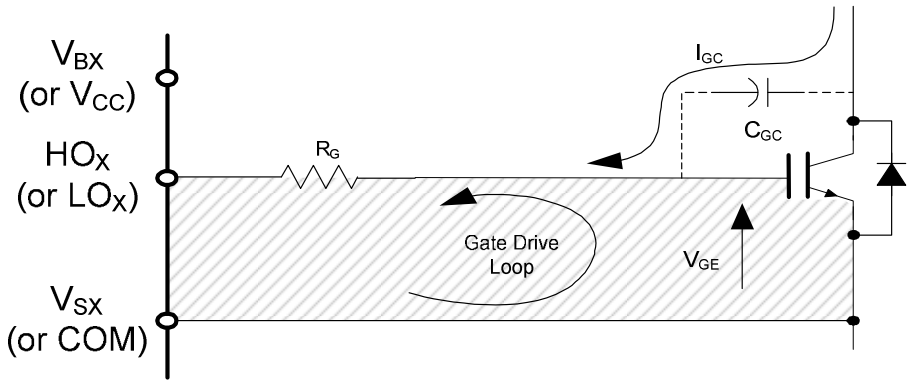


Figure 21: Antenna Loops

Supply Capacitor: It is recommended to place a bypass capacitor (C_{IN}) between the V_{CC} and COM pins. A ceramic 1 µF ceramic capacitor is suitable for most applications. This component should be placed as close as possible to the pins in order to reduce parasitic elements.

Routing and Placement: Power stage PCB parasitic elements can contribute to large negative voltage transients at the switch node; it is recommended to limit the phase voltage negative transients. In order to avoid such conditions, it is recommended to 1) minimize the high-side emitter to low-side collector distance, and 2) minimize the low-side emitter to negative bus rail stray inductance. However, where negative V_S spikes remain excessive, further steps may be taken to reduce the spike. This includes placing a resistor (5 Ω or less) between the V_S pin and the switch node (see Figure 22), and in some cases using a clamping diode between COM and V_S (see Figure 23). See DT04-4 at www.irf.com for more detailed information.

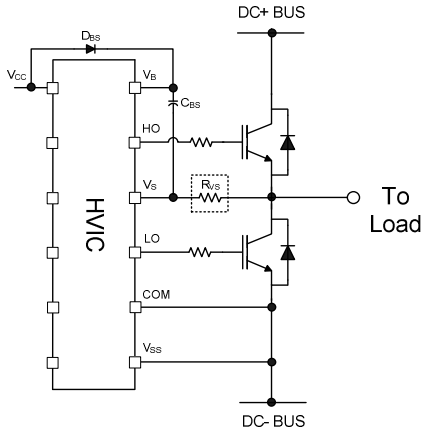


Figure 22: V_S resistor

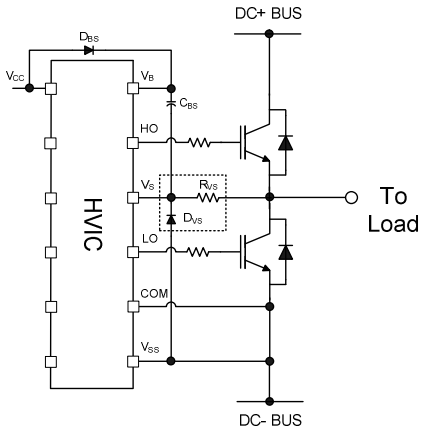


Figure 23: V_S clamping diode

Integrated Bootstrap FET limitation

The integrated Bootstrap FET functionality has an operational limitation under the following bias conditions applied to the HVIC:

- **VCC pin voltage = 0V AND**
- **VS or VB pin voltage > 0**

In the absence of a VCC bias, the integrated bootstrap FET voltage blocking capability is compromised and a current conduction path is created between VCC & VB pins, as illustrated in Fig.24 below, resulting in power loss and possible damage to the HVIC.

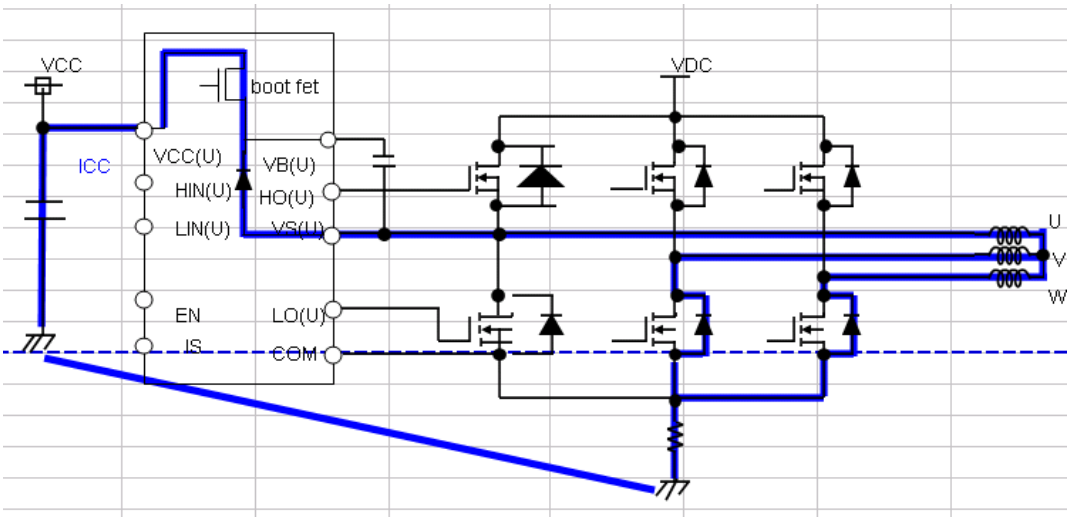


Figure 24: Current conduction path between VCC and VB pin

Relevant Application Situations:

The above mentioned bias condition may be encountered under the following situations:

- In a motor control application, a permanent magnet motor naturally rotating while VCC power is OFF. In this condition, Back EMF is generated at a motor terminal which causes high voltage bias on VS nodes resulting unwanted current flow to VCC.
- Potential situations in other applications where VS/VB node voltage potential increases before the VCC voltage is available (for example due to sequencing delays in SMPS supplying VCC bias)

Application Workaround:

Insertion of a standard p-n junction diode between VCC pin of IC and positive terminal of VCC capacitors (as illustrated in Fig.25) prevents current conduction "out-of" VCC pin of gate driver IC. It is important not to connect the VCC capacitor directly to pin of IC. Diode selection is based on 25V rating or above & current capability aligned to ICC consumption of IC - 100mA should cover most application situations. As an example, Part number # LL4154 from Diodes Inc (25V/150mA standard diode) can be used.

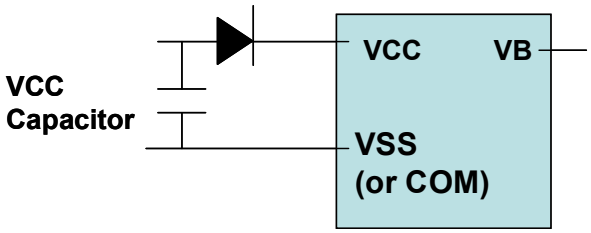


Figure 25: Diode insertion between VCC pin and VCC capacitor

Note that the forward voltage drop on the diode (V_F) must be taken into account when biasing the VCC pin of the IC to meet UVLO requirements. *VCC pin Bias = VCC Supply Voltage – V_F of Diode*.

Additional Documentation

Several technical documents related to the use of HVICs are available at www.irf.com; use the Site Search function and the document number to quickly locate them. Below is a short list of some of these documents.

DT97-3: Managing Transients in Control IC Driven Power Stages
AN-1123: Bootstrap Network Analysis: Focusing on the Integrated Bootstrap Functionality
DT04-4: Using Monolithic High Voltage Gate Drivers
AN-978: HV Floating MOS-Gate Driver ICs

Parameters trend in temperature

Figures 26-49 provide information on the experimental performance of the IRS2609D(S) HVIC. The line plotted in each figure is generated from actual lab data. A large number of individual samples from multiple wafer lots were tested at three temperatures (-40 ºC, 25 ºC, and 125 ºC) in order to generate the experimental (Exp.) curve. The line labeled Exp. consist of three data points (one data point at each of the tested temperatures) that have been connected together to illustrate the understood trend. The individual data points on the curve were determined by calculating the averaged experimental value of the parameter (for a given temperature).

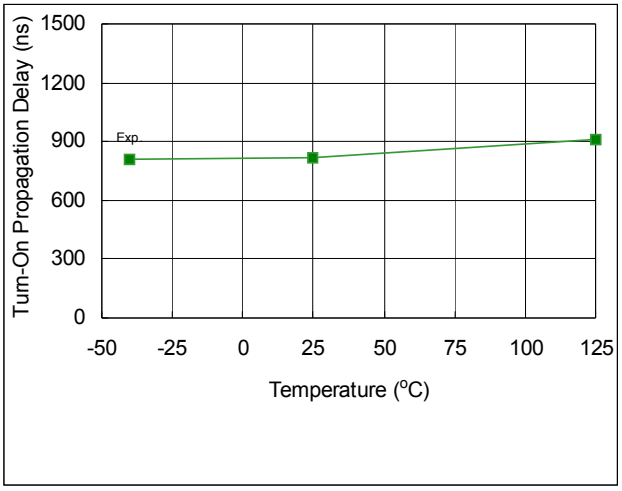


Fig. 26. Turn-on Propagation Delay vs. Temperature

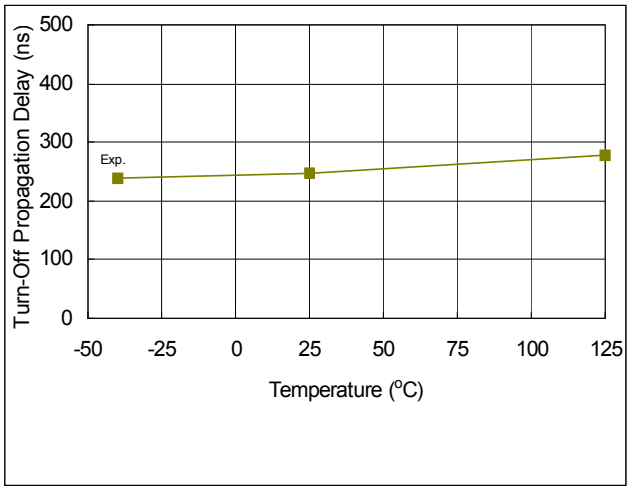


Fig. 27. Turn-off Propagation Delay vs. Temperature

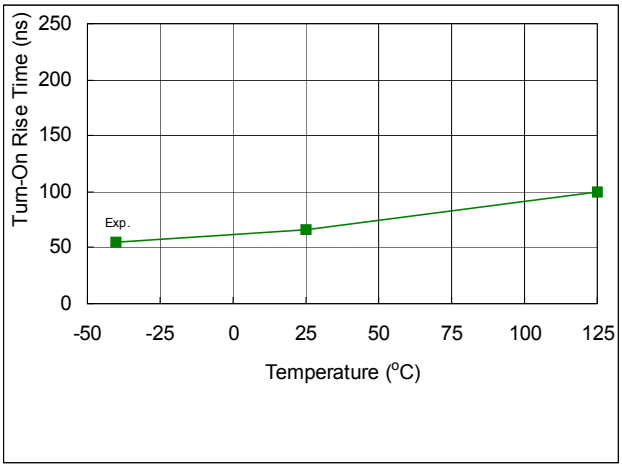


Fig. 28. Turn-on Rise Time vs. Temperature

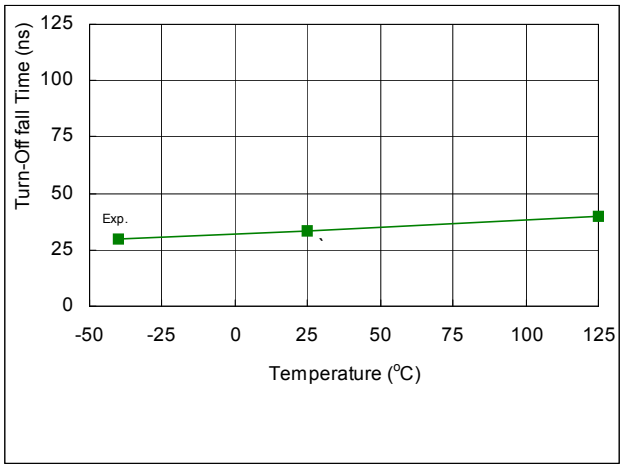


Fig. 29. Turn-off Rise Time vs. Temperature

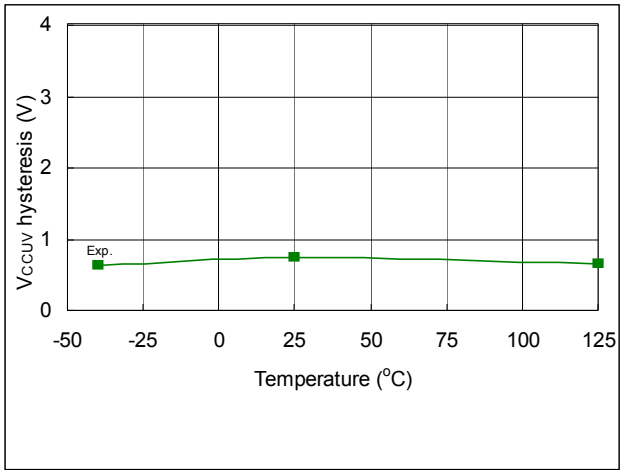


Fig. 30. V_{CC} Supply UV Hysteresis vs. Temperature

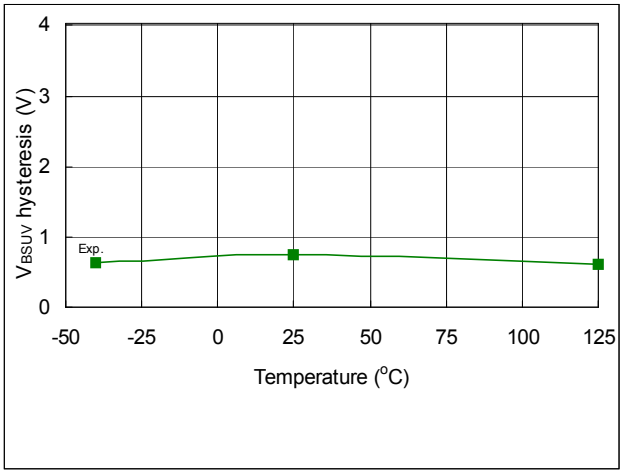


Fig. 31. V_{BS} Supply UV Hysteresis vs. Temperature

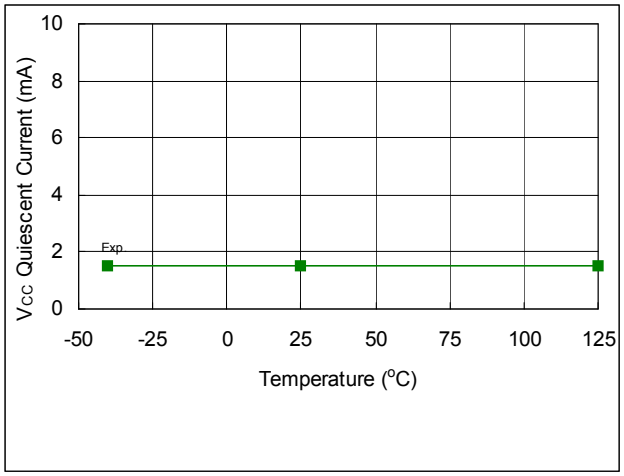


Fig. 32. V_{CC} Quiescent Supply Current vs. Temperature

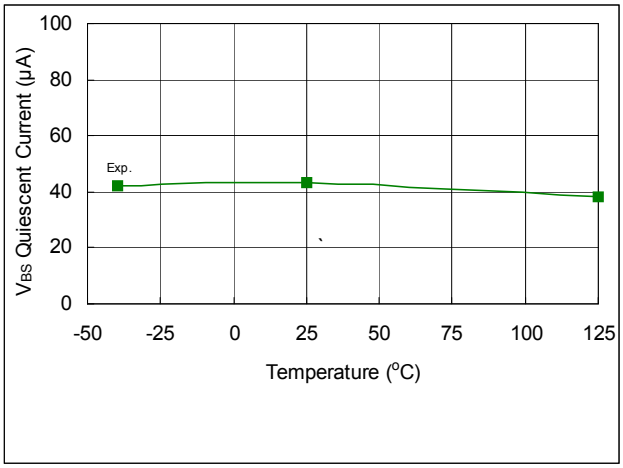


Fig. 33. V_{BS} Quiescent Supply Current vs. Temperature

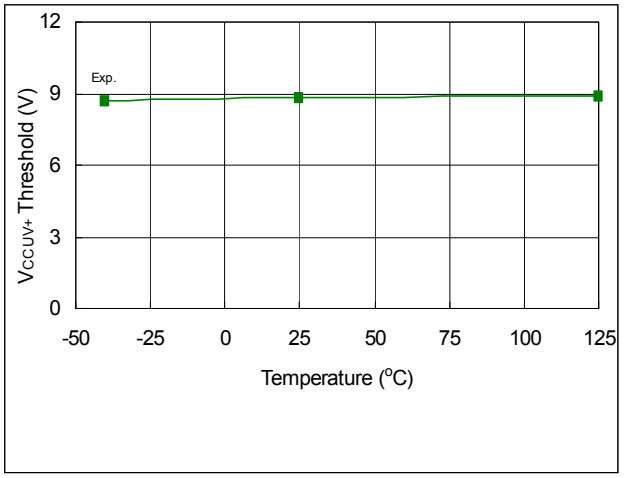


Fig. 35. V_{CCUV+} Threshold vs. Temperature

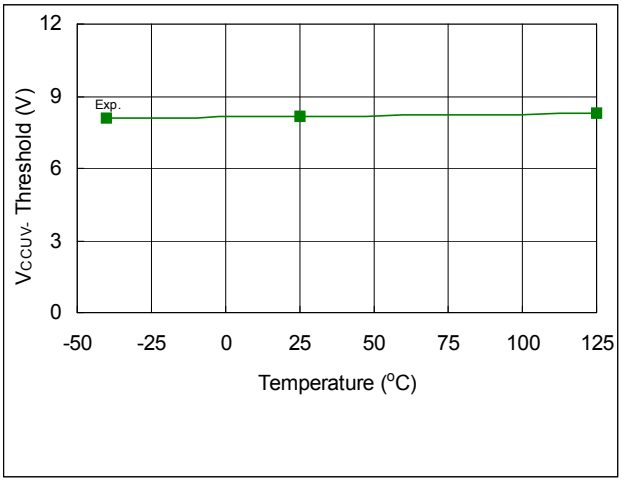


Fig. 36. V_{CCUV-} Threshold vs. Temperature

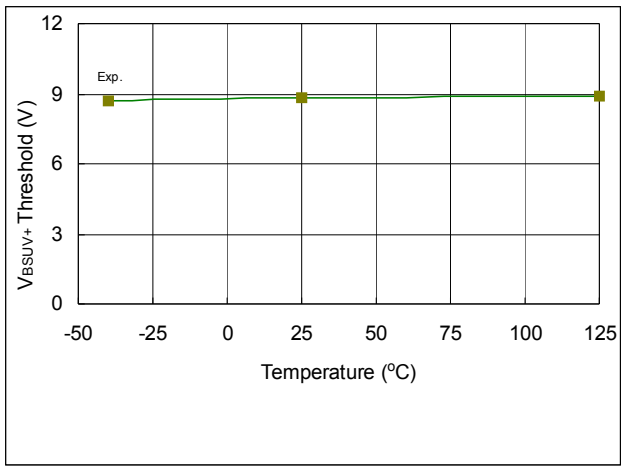


Fig. 37. V_{BSUV+} Threshold vs. Temperature

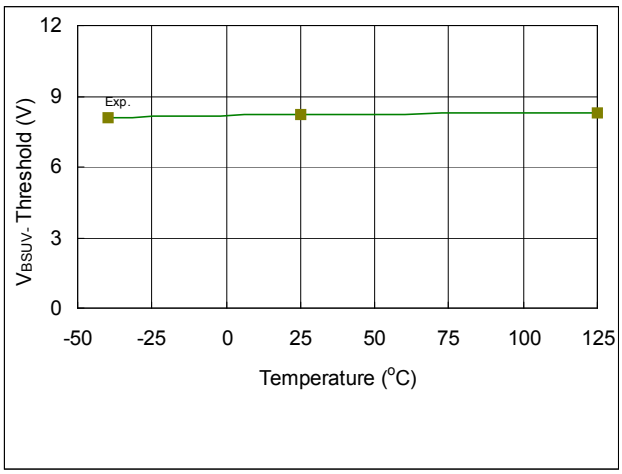


Fig. 38. V_{BSUV-} Threshold vs. Temperature

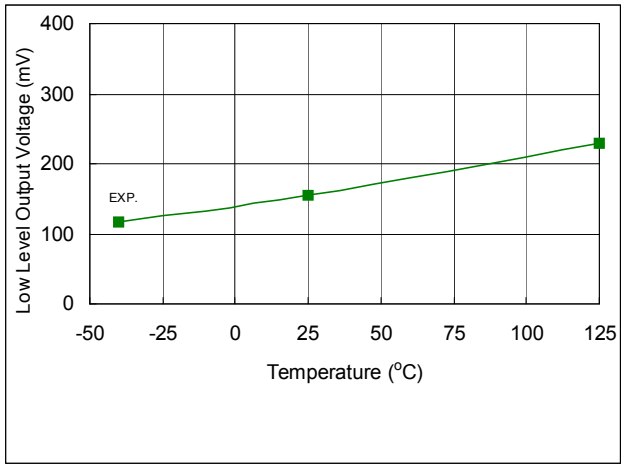


Fig. 38. Low Level Output Voltage vs. Temperature

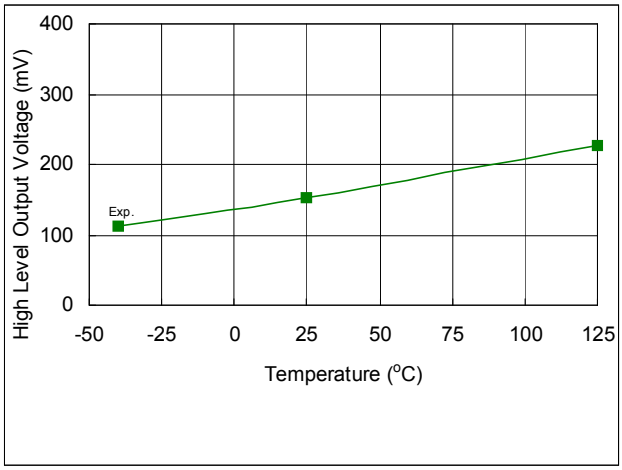


Fig. 39. High Level Output Voltage vs. Temperature

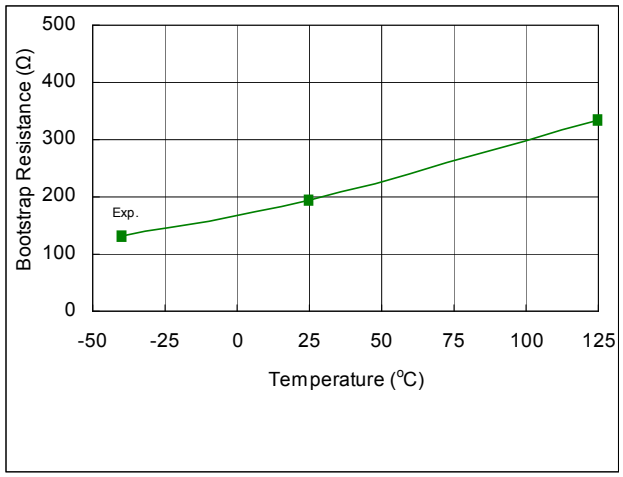


Fig. 40. Bootstrap Resistance vs. Temperature

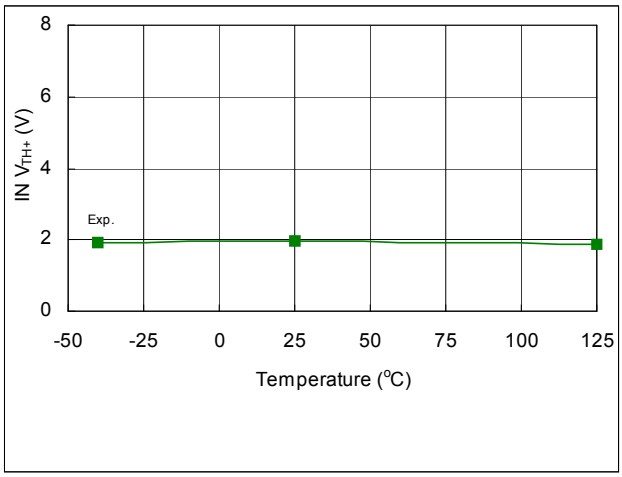


Fig. 41. IN V_{TH+} vs. Temperature

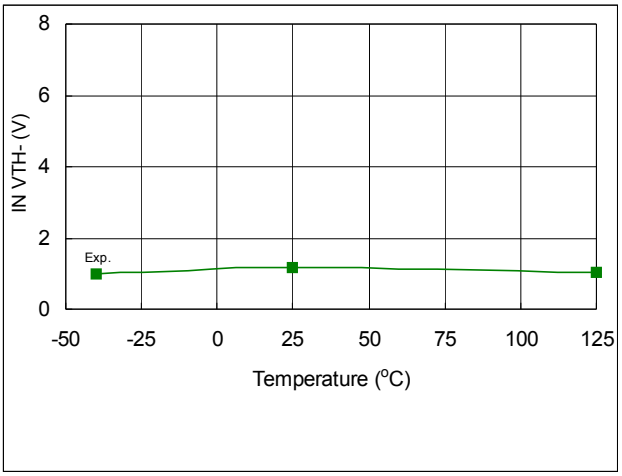


Fig. 42. LIN V_{TH-} vs. Temperature

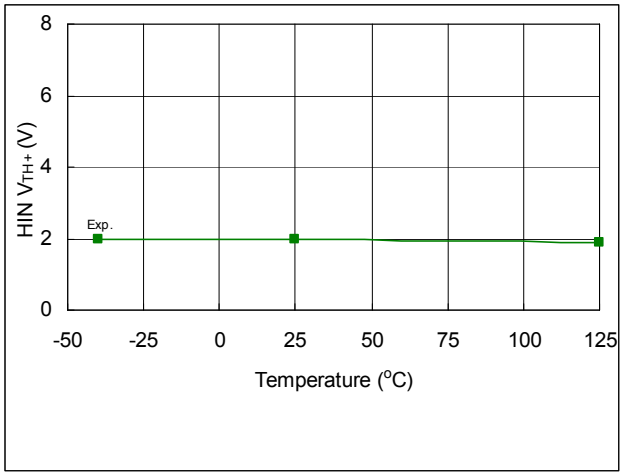


Fig. 43. HIN V_{TH+} vs. Temperature

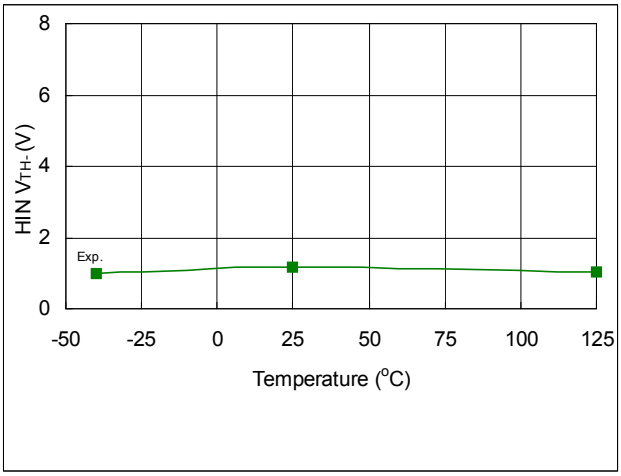


Fig. 44. HIN V_{TH-} vs. Temperature

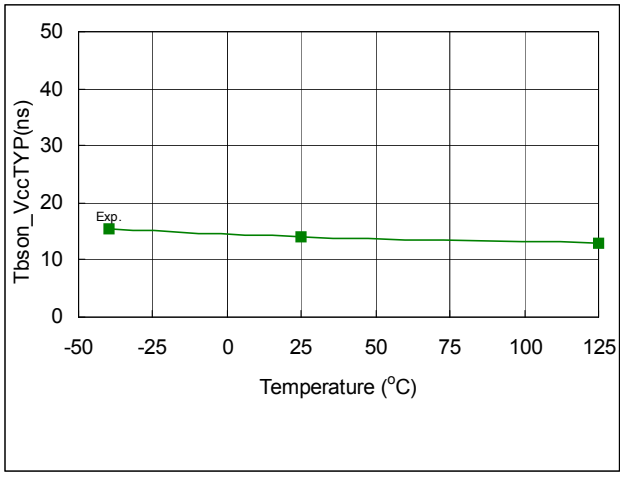


Fig. 45. Tbson_V_{CC}TYP vs. Temperature

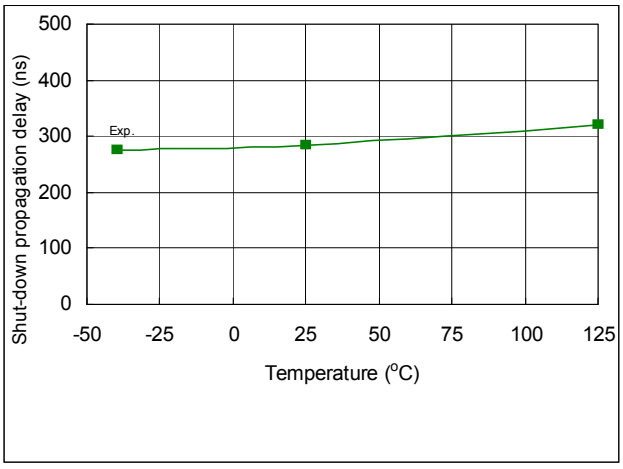


Fig. 46. Shut-down Propagation Delay vs. Temperature

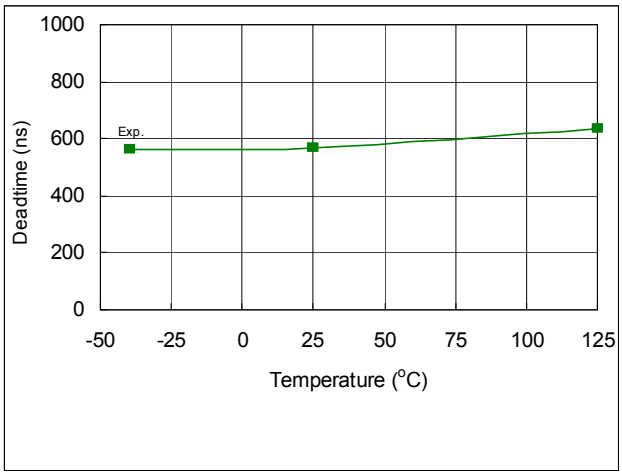


Fig. 47. Deadtime vs. Temperature

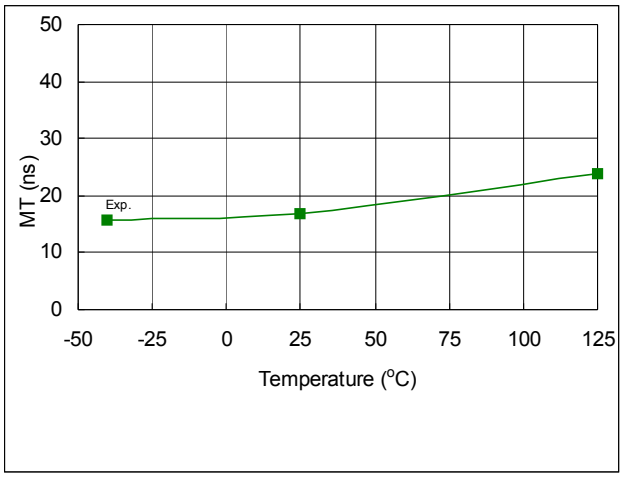


Fig. 48. Delay Matching vs. Temperature

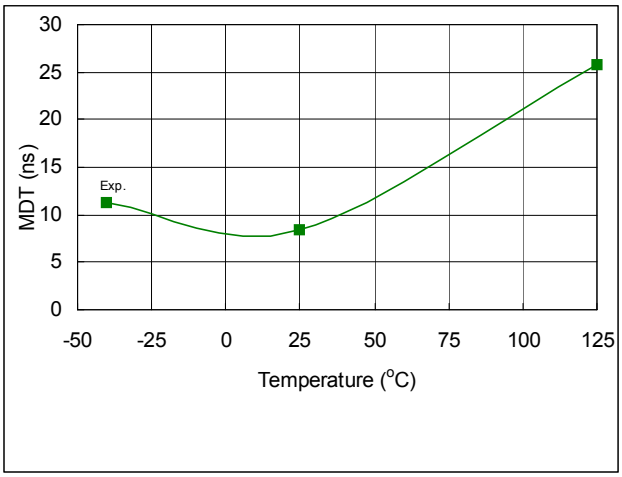
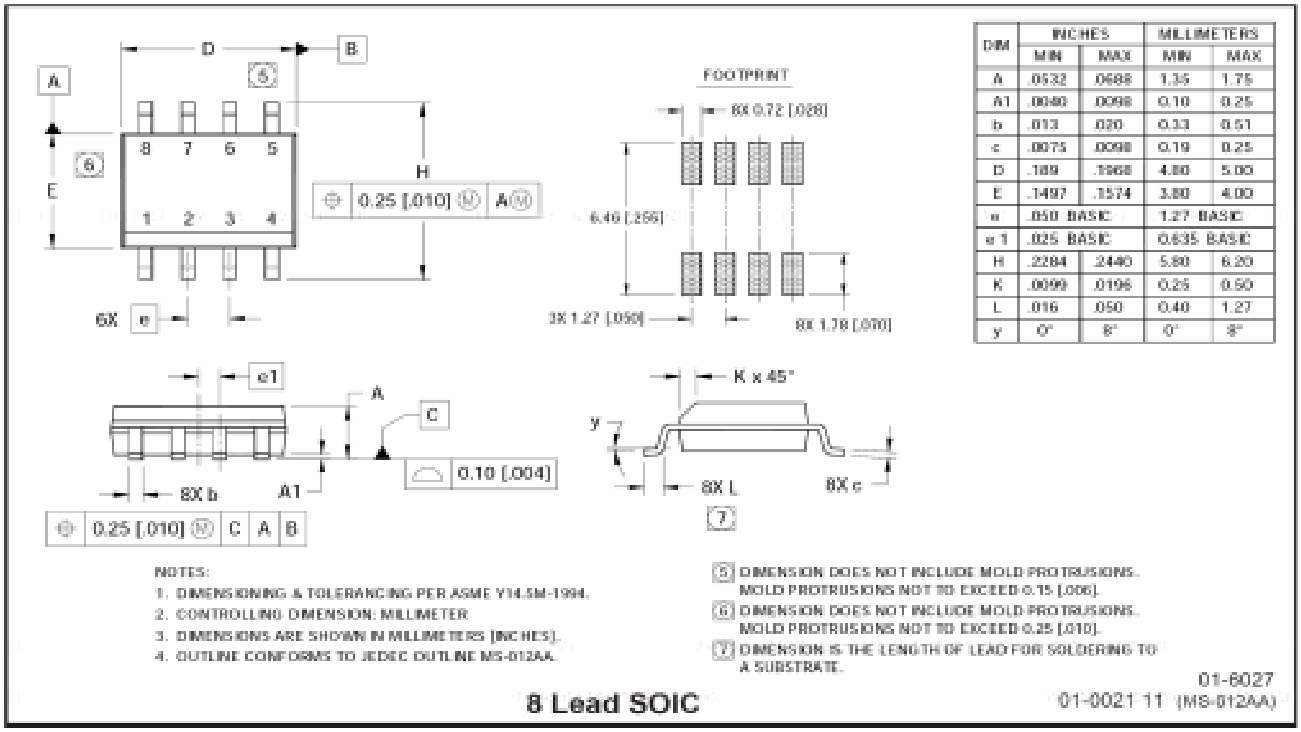


Fig. 49. Deadtime Matching vs. Temperature

Case Outlines



DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	.0532	.0688	1.35	1.75
A1	.0040	.0098	0.10	0.25
b	.013	.020	0.33	0.51
c	.0075	.0098	0.19	0.25
D	.189	.1968	4.80	5.00
E	.1497	.1574	3.80	4.00
e	.050 BASIC		1.27 BASIC	
e 1	.025 BASIC		0.635 BASIC	
H	.2284	.2440	5.80	6.20
K	.0099	.0196	0.25	0.50
L	.016	.050	0.40	1.27
y	0°	8°	0°	8°

NOTES:
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.

5 DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.15 [.006].

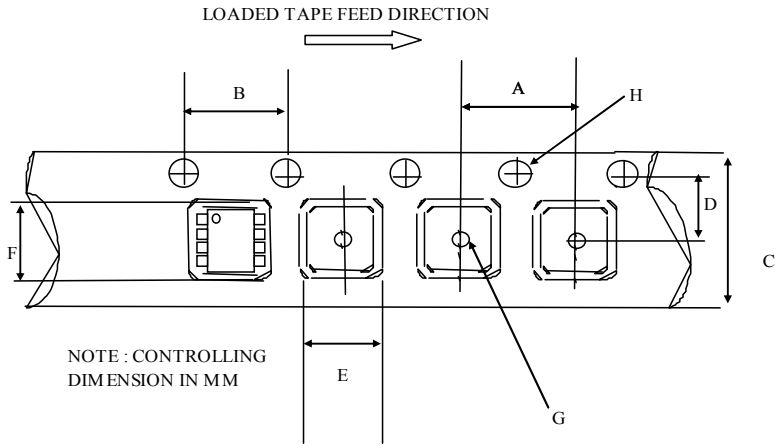
6 DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 [.010].

7 DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.

01-6027
01-0021 11 (MS-012AA)

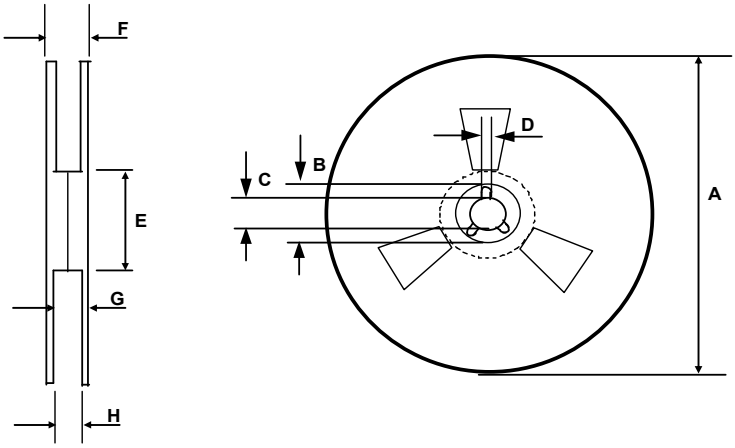
8 Lead SOIC

Tape and Reel Details: 8L-SOIC



CARRIER TAPE DIMENSION FOR 8SOICN

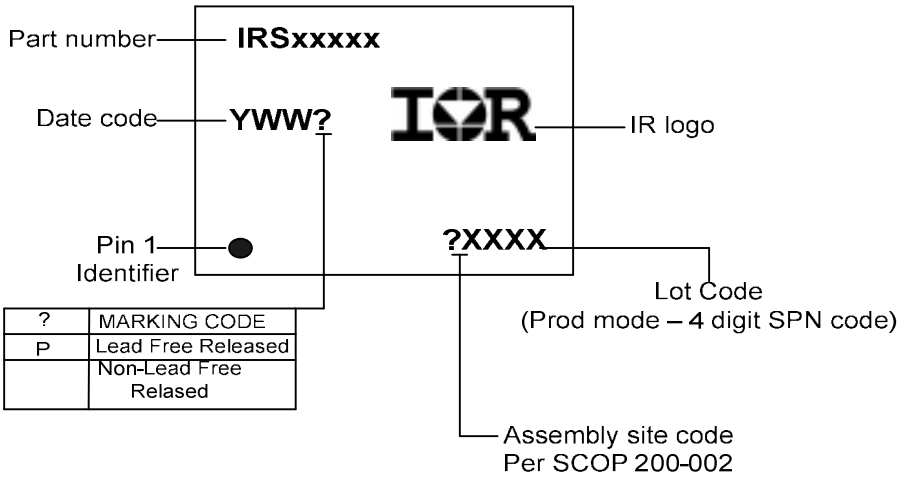
Code	Metric		Imperial	
	Min	Max	Min	Max
A	7.90	8.10	0.311	0.318
B	3.90	4.10	0.153	0.161
C	11.70	12.30	0.46	0.484
D	5.45	5.55	0.214	0.218
E	6.30	6.50	0.248	0.255
F	5.10	5.30	0.200	0.208
G	1.50	n/a	0.059	n/a
H	1.50	1.60	0.059	0.062



REEL DIMENSIONS FOR 8SOICN

Code	Metric		Imperial	
	Min	Max	Min	Max
A	329.60	330.25	12.976	13.001
B	20.95	21.45	0.824	0.844
C	12.80	13.20	0.503	0.519
D	1.95	2.45	0.767	0.096
E	98.00	102.00	3.858	4.015
F	n/a	18.40	n/a	0.724
G	14.50	17.10	0.570	0.673
H	12.40	14.40	0.488	0.566

LEAD-FREE PART MARKING INFORMATION



?	MARKING CODE
P	Lead Free Released
	Non-Lead Free Relased

ORDER INFORMATION

8-Lead SOIC IRS2609DSPbF

8-Lead SOIC Tape & Reel IRS2609DSTRPbF

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http://www.irf.com/technical-info/

WORLD HEADQUARTERS:
233 Kansas St., El Segundo, California 90245
Tel: (310) 252-7105

Revision History

Revision	Date	Comments/Changed items
1.5	03-17-08	Added application note to include negative Vs curve
1.6	03-17-08	Added Qualification Information on Page 2, Disclaimer information on Page 25, and updated information on Pages 21-23
1.6a	03-21-08	Removed revision letter from JEDEC standards under Qualification Information table.
1.7	04-18-08	Added "RoHS compliant" statement to front page, Changed latch up level to A, added MT parameter.
	May 8, 08	Changed file name from using revision to using date, Page1: corrected IGBT, Page5: corrected p/n on lead assignment diagram to IRS2609DS
	06-18-08	Corrected internal dead time on front page to 530ns instead of 540ns.
	08-18-2009	Removed reference to trapezoidal modulation in Integrated Bootstrap Functionality section